

Nesting Behavior of the Anemonefish *Amphiprion polymnus*

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In recent years, studies of the reproductive behavior of various species of anemonefishes have shown a high degree of similarity between species (Allen, 1972; Fricke, 1974; Bell, 1976; Moyer and Bell, 1976; Ross, 1978). Characteristically, anemonefishes lay their eggs on coral or rocky substrate directly under the extended tentacles of the host anemone. *Amphiprion polymnus* (Linnaeus) shows unique differences in methods of nest construction compared to other anemonefishes. The present paper reports on these differences.

Results

Distribution and habitat. The anemonefish *Amphiprion polymnus* was studied in the Ryukyu Islands, Japan, by Moyer and in the waters of Papua-New Guinea by Steene. *A. polymnus* occurs from the Indo-Australian Archipelago to Japan (Allen, 1972). In Japan it is rare. In more than 50 hours of searching during visits to Okinawa-jima, Miyako-jima, and Kuro-shima in the Ryukyu Islands, we found it only in a very restricted habitat along the coast of Tsuken-jima, a small island at the northeast end of Nakagusuku Bay, Okinawa-jima. However, *A. polymnus* was more abundant along the northern coast of Papua-New Guinea. Our studies were conducted in October, 1977, at Tsuken-jima, and at Papua-New Guinea in August and September 1976.

Most observations, both at Papua-New Guinea and in Japan, were made at depths ranging between 2~4 m over sand bottom, although nests were sometimes found at depths of about 30 m in sand at Papua-New Guinea. In Japan, *A. polymnus* was associated with the sand-dwelling anemone *Stoichactis haddoni* (Saville-Kent); however, at Papua-New Guinea it was found with both *Stoichactis* sp. and *Radianthus kuekenthali* (Kwietniewski). Usually the host anemone was relatively well-

concealed in a bed of sea grass (*Halodula* sp.) (Fig. 1A), but rarely individuals were found in bare sand (Fig. 1B). Patches of coral rubble were invariably found within 30 m of the host anemone. When vigorously pursued, female *A. polymnus* eventually took shelter in the closest patch of coral rubble. Males remained in the vicinity of their anemone, swimming in rapid erratic circles in mid-water.

Nesting behavior. Sand-dwelling anemones provide no solid nesting surface for symbiotic fishes. *Amphiprion polymnus* solves this problem by pushing and/or dragging a suitable nesting surface from somewhere within its range of activities. Objects observed as nesting surfaces included a sand dollar test, the empty shell of a bivalve mollusc (Pinnidae) (Fig. 2A, B), discarded soft drink cans (Fig. 1B), and a palm frond (Fig. 3A, B).

In all cases the nesting surfaces were partially or totally covered by the anemone tentacles when the disc was fully extended. The sand dollar test, about 10 cm in diameter, which supported a clutch of about 400 eggs estimated to be about 3~4 days old (see Bell, 1976), had apparently only recently been pushed to the anemone. Tracks still remained in the sand as evidence that the nesting fish had pushed it over a distance of at least two meters, a task undoubtedly requiring considerable effort, due to the weight of the object and the soft nature of the sand. The nesting fish at this site measured 106 mm and 102 mm in standard length.

Soft drink cans are relatively common at the Tsuken-jima site during summer, because the nearby beach is a tourist resort. The can shown in Fig. 1B not only served as a nesting surface for the adults (77 mm and 76 mm in SL), but also provided shelter for the smallest juvenile, which took refuge inside of it when pursued.

Discussion

Habitat and body size. Large anemonefishes, e.g. *Amphiprion clarkii* (Bennett), *A. melanopus* Bleeker, *A. chrysopterus* Cuvier, *A. bicinctus* Rüppell, *A. frenatus* Brevoort, etc., do not always find shelter within the tentacles of

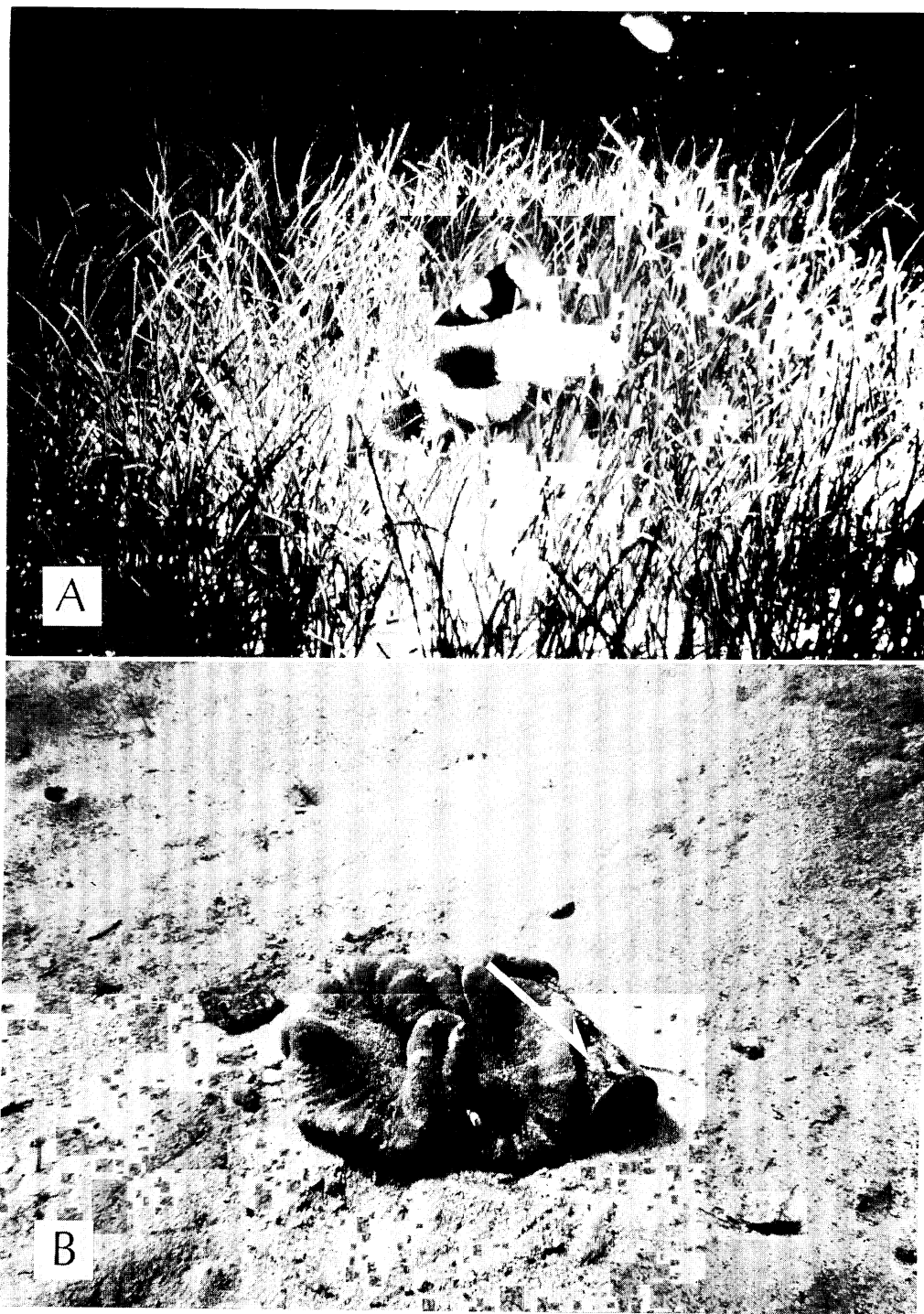


Fig. 1. A: Typical habitat of *Amphiprion polymnus* at Tsuken-jima, Okinawa, with *Stoichactis haddoni* anemone in sea grass *Halodula* sp. B: Host anemone (*Stoichactis haddoni*) in bare sand. Note soft drink can used as nesting surface (arrow) and juvenile fish. Photo by D. F. Dunn.



Fig. 2. A: Adult *A. polymnus* fans eggs on empty mollusc shell (Pinnidae) (arrow). B: Eggs of *A. polymnus* on empty shell of mollusc (Pinnidae).



Fig. 3. A: Adult *A. polymnus* fans eggs on palm frond at Rabaul, Papua-New Guinea. Photo by R.C. Steene. B: Male *A. polymnus* mouthing eggs on palm frond. Photo by R.C. Steene.

their host anemone. When pursued they will often seek shelter in a crevice or crack somewhere near the anemone (Allen, 1972; Fricke, 1974; Moyer and Bell, 1976; personal observations). Anemones of the genus *Stoichactis* have tentacles far too short to provide shelter for adults of the large anemonefish species, requiring that the symbiotic fish seek shelter under the disc or in crevices nearby.

Verwey (1930), Allen (1972), Fricke and Fricke (1977), and Moyer and Nakazono (1978) have remarked on the obvious size dimorphism in several species of *Amphiprion*, females being noticeably larger than males. Fricke and Fricke (1977) related this difference to the advantage of comparatively large body size for production of clutches of large-sized eggs (e.g. 2.7×0.9 mm for *A. clarkii*) with well-developed embryos. They further suggested that larger body size permitted females to range a bit further from the host anemone than their mates, by somewhat reducing potential predation, and that the female's larger size contributed to the evolution of protandry as the reproductive strategy of anemonefishes (Fricke and Fricke, 1977; Moyer and Nakazono, 1978).

However, males and females of *A. polymnus* are almost equal in size (Moyer and Nakazono, 1978), differing from most *Amphiprion* species and seeming not to fit the Fricke hypothesis. This discrepancy is almost certainly due to the nature of the habitat. Sand-dwelling host anemones were observed to withdraw completely into the sand when under stress, leaving *Amphiprion polymnus* totally exposed to potential predation. With no shelter nearby, *A. polymnus* is forced to elude predators by rapid erratic swimming in the water column or by fleeing relatively long distances to seek shelter in coral rubble. The male cannot merely slip into a crevice near the anemone until danger has passed, as is characteristic of other species. Consequently, males are large. Shallow water and a sand substrate, of course, eliminate many potential predators, e.g. serranids and moray eels; however, during our observations we often saw the lizardfish *Synodus variegatus* (Lacepède) and several schools of small barracuda, *Sphyræna* spp. The comparatively large size of both males

and females of *A. polymnus* undoubtedly provides some protection against such well-known piscivores.

Nesting behavior. The use of mollusc shells and man-made objects as nesting surfaces by pomacentrid fishes is well-known (e.g. Brinley, 1939; Emery, 1973). Matsuoka (1962) and Moyer (1975) placed plastic pipes near populations of *Pomacentrus coelestis* Jordan et Starks and *P. nagasakiensis* Tanaka and were able to successfully induce nesting. In every example known to us, the territory of the nesting fish was established around the nesting object, i.e. the nesting surface determined the location of the territory, and the territory could be moved by moving the nesting surface. *Amphiprion polymnus* represents a unique situation in which the territory is pre-determined by the presence of the host anemone and the nesting surface must be selected elsewhere and somehow transported to the territory.

All pomacentrids including *Amphiprion* spp. are known to move relatively large objects from the nesting area during nest construction and/or nest cleaning (e.g. Moyer, 1975). This widely-known practice, certainly of ancient origin, probably pre-adapted *A. polymnus* for its unique form of nest construction, which utilizes the same motor patterns.

Stoichactis anemones are also known to host *Amphiprion clarkii* (Uchida et al., 1975; Moyer, 1976; Moyer and Bell, 1976). Usually, these anemones are found in sand and are used only by *A. clarkii* juveniles as "nursery anemones" (Moyer, 1976). However, at Miyake-jima, in the Izu Islands of southern Japan, *Stoichactis haddoni* is sometimes found anchored in narrow crevices between volcanic rock faces. In such cases, nesting pairs of *A. clarkii* are invariably present (Moyer and Bell, 1976). *Radianthus kuekenthali* is commonly occupied by *A. clarkii* in tropical waters, where it is usually found anchored to corals (Dunn, personal communication; Moyer and Steene, personal observations). *A. polymnus* does not occur at Miyake-jima. It is suggested that the unusual nesting behavior of *Amphiprion polymnus* evolved under the selective pressures of competition with *A. clarkii* for anemone shelter.

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トウアカクマノミ *Amphiprion polymnus* の営巣習性

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クマノミ類 (スズメダイ科) がイソギンチャクと共生し、イソギンチャクの触手または口盤におおわれたサンゴ礁面あるいは岩礁面に産卵する習性をもつことは近年周知の事実になっている。著者らが琉球列島とバブアニューギニアで観察したトウアカクマノミ *Amphiprion polymnus* は、イボハタゴイソギンチャク *Stoichactis haddoni* と共生・営巣する。イボハタゴイソギンチャクは砂底に生息するので、岩礁、サンゴ礁のような産卵床がない。トウアカクマノミはこの口盤の下に付近から不正形類棘皮動物の殻、二枚貝の殻、清涼飲料水の空缶、ヤシの葉等を運び、そこに産卵する。本種の営巣習性はこの点で他のクマノミ類と異なっている。

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